

Characteristics of non-response in the Danish Health Interview Surveys, 1987–1994

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Background: The types and quantity of non-response in surveys influence the extent to which the results may be generalized. This study analysed trends in non-response in the Danish Health Interview Surveys from 1987 to 1994 and used the National Patient Registry to assess whether non-response biased the estimated population prevalence of morbidity when solely based on responders. **Methods:** The data were for the 23 096 adults sampled for the Danish Health Interview Surveys in 1987, 1991 and 1994. All were followed using the National Patient Registry to obtain such information as hospital admissions. **Results:** Non-response increased from 20.0% in 1987 to 22.6% in 1994. Four combinations of background variables characterized the non-response: gender and age; gender and civil status; county of residence and age; survey year and age. Non-respondents and respondents had identical gender- and age-standardized hospital admission rates for ~5 years before and 2 years after data collection, but non-respondents had a significantly higher rate immediately before and during data collection. Admissions rates were analysed according to reasons for non-response. Refusers had a lower admission rate than respondents before data collection but similar during and after data collection. The rate was higher during the whole period among ill or disabled non-respondents. Among people who could not be contacted during the data collection period a higher admission rate was only found immediately before and during data collection. **Conclusions:** Although admission rates differed between respondents and non-respondents these differences were too small to bias the estimated population prevalence of morbidity when solely based on responders.

Keywords: bias (epidemiology), estimation of morbidity, health interview surveys, non-response (questionnaires)

An important aim of regular representative health interview surveys is to measure the prevalence of various indicators of health and morbidity for the entire population and to assess trends over time. The quality of the data collected influences how well the actual health and morbidity of the population is estimated, particularly as these estimates are based solely on responders.

Non-response is a collective term for the people (called non-respondents or non-participants) who are invited to participate in a survey but do not do so. Several factors influence the proportion of non-response: the method of collecting data;^{1,2} the survey theme; the length of the interview or questionnaire;^{3,4} and the interviewers' skill in contacting the selected people. Health interview surveys in Europe usually have a 10–30% non-response.⁵ Non-response is often not differentiated, despite very different reasons for not responding. For example, there may be no differentiation between people who refuse to participate (refusals), non-respondents who could not be contacted and non-respondents who are ill or disabled. Only a few surveys have demonstrated differences in socio-demographic, lifestyle and morbidity factors between various types of non-respondents.^{6–9}

Composition of non-response

Compared with respondents, non-respondents are more often never married or single,^{10–12} have less education and lower socio-economic status^{11–14} and more often live in highly urbanized areas.^{6,15} Some studies report increasing non-response with increasing age,^{16–18} some report decreasing non-response with increasing age.^{3,12}

The relative prevalence of morbidity among respondents and non-respondents varies in different studies. Some have found

that respondents have higher overall morbidity than non-respondents^{19,20} and that non-respondents have a higher prevalence of mental disorders or reduced mental capacity.^{14,21–23} Some demonstrate higher morbidity among non-respondents for some diagnoses but not others^{12,17,24} and some no differences in morbidity between respondents and non-respondents.^{11,25,26} Finally, some find that non-respondents have lower morbidity than respondents.^{27,28}

Studies of health care utilization among respondents and non-respondents have not shown clear results either. Both Lamers¹⁵ and Reijneveld and Stronks¹⁰ found that non-respondents used fewer health care services of nearly all types than did respondents (but no difference for hospital admissions). Other studies show greater utilization among non-respondents than among respondents, including hospital admissions.^{29,30}

Purpose

This study investigated whether the non-response biases the estimated population morbidity. The objectives were:

- to describe and analyse trends in non-response and the composition of the non-respondents in the 1987, 1991 and 1994 surveys; and
- to analyse hospital admissions before, during and after the survey interview among respondents and non-respondents in order to access whether non-response might bias the estimation of health and morbidity in the population when based solely on responders.

Methods

Study population

The study covered all 23 096 people selected to participate in the representative Danish Health Interview Surveys, which the National Institute of Public Health conducted in 1987, 1991 and

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1994. All samples were drawn from the Central Personal Register (CPR) and included Danish citizens 16 years or older residing in Denmark, including those living in institutions. The national samples were representative for Denmark's population regarding gender, age, civil status and county of residence.^{31–33}

Data were collected by personal interview in the respondents' home. In each survey data were collected in three rounds in February, May and September. Immediately before each data collection round, an introductory letter was sent to the people selected to participate briefly explaining the purpose and content of the survey. The letter stated that participation was voluntary and that the respondents would be ensured anonymity in connection with the publication of the survey results. Data from the three HIS were pooled into a common database, the Danish National Cohort Study (DANCOS).³⁴ By using the unique personal identification number all sampled persons were followed in several registries, including the National Patient Registry, wherefrom we obtained data on hospital admissions before and after the data collection period of each survey.

Variables

From the CPR we had information on gender, age, civil status and county of residence. In the non-response analysis, residence was dichotomized into metropolitan Copenhagen (defined as the City of Copenhagen, the City of Frederiksberg and Copenhagen County) and the rest of Denmark.

The date and result of every attempted contact with an invited person was registered in the following categories: (i) interview (complete or incomplete), (ii) refusal, (iii) illness, disabled, gone away or in hospital, (iv) not contacted, (v) dead, moved outside Denmark or (vi) other. 'Illness, disability, gone away or at hospital' was used if information was available from the invited person or from a relative. 'Not contacted' means that the interviewer could not contact the person despite at least three attempts. Sixty-two people died or moved outside Denmark during the data collection and were therefore excluded from this analysis.

The overall hospital admission rate was used as the operational measure of morbidity. Information was obtained from the National Patient Registry via the DANCOS database on all admissions among the invited people from 5 years before data collection until 2 years afterwards. The admission rate was dichotomized semi-annually: one or more admission versus none during each 6-month period.

Statistical analysis

Logistic regression (SAS PROC GENMOD) was used. The model for analysing the total non-response included the background variables available from the CPR (i.e. gender, age, civil status, county of residence) and survey year and all two-way interactions. (Preliminary analysis showed no three-way interaction with survey year.) Backwards selection was carried out. Each non-response category was analysed using the final model for the analysis of the total non-response: thus, each non-response group was compared with the respondents and further backwards selection was performed if necessary. Odds ratios were estimated in a model with a single interaction effect and the other variables as main effects.

The association between non-response and hospital admission before, during and after data collection was analysed by calculating the gender- and age-standardized admission rate for the total non-response and for each separate category for each 6-month period. Non-response groups were gender- and age-standardized relative to the respondents. The analyses were tested using Poisson regression, in which the rate means the number of admissions per person-year at risk. This approach was chosen because the person-year at risk might decrease differently for

the non-respondents and respondents during and after the interview period due to a potential different morbidity rate in the two groups. For the sake of clarity the semi-annual admission periods were categorized into five larger periods.

Results

Table 1 shows the results of data collection in the three surveys. The response rate declined from 1987 and 1991 to 1994, mainly because refusals increased considerably, from 12.1% in 1987 and 12.2% in 1991 to 16.4% in 1994. Further, the proportion not contacted declined because, in the third round of data collection in 1994, we tried again to contact the non-contacted people from the first two rounds. Thus, about half of those who had not previously been contacted were interviewed.

The non-response in all three surveys was identical among men and women, increased with age, was higher among widows/widowers and among divorced people and higher in metropolitan Copenhagen than in the rest of Denmark (table 1).

Total non-response

Multivariate analysis including all background variables and their combinations shows that the prevalence of non-response can only be described thoroughly by using combinations of the background variables. Four combinations describe the prevalence best: (i) gender and age (figure 1), men have higher odds for non-response than women among those 16–59 years old and women higher odds among those 60 years or older; (ii) survey year and age, the odds of non-response increased steadily with age, and the increase was considerably steeper from 70 to 80 years of age in 1991 and 1994 versus 1987 (figure 2); (iii) gender and civil status, married men and women had identical non-response; men had higher non-response than women among those divorced or never married and widows higher non-response than widowers (table 3); (iv) non-response was higher in metropolitan Copenhagen than in the rest of Denmark for all age groups, with the greatest difference over 50 years of age (table 3).

Categories of non-respondents

Table 3 also compares each non-respondent category with the respondents.

Refusals

All four combinations of background variables apply to refusals, which comprised 65.9% of non-respondents.

III, disabled or in hospital

Non-response varied by age, civil status and county of residence but not by gender or survey year, and not by the four combinations of background variables described. Non-response increased with increasing age, but the odds of non-response tripled from those 70–79 years old (OR 4.2) to those 80 years or older (OR 12.8) in this group.

Not contacted

In contrast to the total non-response, those 20–59 years old had the highest odds for not being contacted, and the 1994 survey the lowest odds for non-respondents not being contacted (because of the enhanced efforts to collect data from this group). Men had substantially higher odds for non-response than women among those divorced and never married, as did both men and women among those divorced, never married and widows/widowers than among the total non-respondents. The OR for divorced men was 8.6 (versus 1.9 among the total non-respondents) and

Table 1 Prevalence of non-response in total and according to gender, age, civil status and county of residence ¹⁾ in the Danish Health Interview Surveys in 1987, 1991 and 1994

	1987	1991	1994	Total	Number in sample
Total non-response	20.0	19.5	22.4	20.8	4804
Refusals	12.1	12.2	16.4	13.7	3164
Ill, disabled, in hospital or gone away	3.7	3.4	3.7	3.6	832
Not contacted	3.0	2.6	1.4	2.3	531
Other	1.0	1.0	0.7	0.9	208
Dead or moved outside Denmark	0.2	0.3	0.3	0.3	69
Gender					
Men	20.0	19.9	22.5	20.9	11,194
Women	19.9	19.2	22.4	20.7	11,902
Age					
16–19 years	18.1	12.8	15.5	15.8	1586
20–29 years	19.1	18.1	19.2	18.9	4190
30–39 years	17.2	15.7	18.2	17.2	4137
40–49 years	20.1	17.5	21.7	20.1	4277
50–59 years	20.5	20.8	22.3	21.3	3137
60–69 years	21.0	21.5	25.1	22.7	2674
70–79 years	23.8	24.6	30.6	26.5	2071
80+ years	26.3	38.1	42.0	35.7	1024
Civil status					
Married	16.4	15.9	19.3	17.4	11,862
Widow or widower	24.8	29.8	34.7	29.8	2040
Divorced	28.0	24.5	26.0	26.3	1839
Never married	22.6	21.0	23.2	22.4	7355
County of residence					
Metropolitan Copenhagen	28.2	27.1	28.8	28.1	4186
Rest of Denmark	18.2	17.5	21.2	19.2	18,896
Number of people sampled	8363	5986	8747		23,096

a: Fourteen people had inadequate information on county of residence

6.4 for never-married men (versus 2.5 among the total non-respondents).

Hospital admission rates and non-response

Figure 3 shows the gender- and age-standardized hospital admission rates among respondents and non-respondents from 5 years before data collection until 2 years afterwards. Respondents and non-respondents had identical rates until 6 months before data collection. The rate increased clearly and statistically significantly from 6 months before data collection started and throughout data collection. After data collection, the non-respondents' rate declined to that for respondents (table 3).

By type of non-respondents, the rate before data collection was significantly lower among refusals than among respondents (table 3). Further, ill or disabled non-respondents had a significantly higher rate than respondents in the entire period, whereas the rate among those not contacted relative

to respondents was only significantly higher in the year before data collection and during data collection.

Discussion

This study has three major strengths. First, we have analysed non-response not only according to traditional socio-demographic background variables but also according to hospital admissions. Second, we have analysed hospital admissions among both respondents and various groups of non-respondents not only during the data collection phase of the survey but also in a period from 5 years before the survey until 2 years after. Third, non-response was analysed based on data available from data collection for the nationwide health survey and from subsequent registry comparison and not from a separate supplementary survey of non-respondents, who provide inherently invalid results based on their previous pattern of non-response.

Table 2 Odds ratios (based on logistic regression) for various socio-demographic categories of respondents versus non-respondents and for each type of non-response versus response.

	All non-respondents			Refusals			Ill, disabled, in hospital			Not contacted		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Men	1.0			1.0			1.0			1.0		
Women	0.9	0.9–1.0		1.0	1.0–1.1		0.9	0.8–1.1	NS	0.6	0.5–0.7	
16–19 years	1.0	1.0–1.0		1.0			1.0			1.0		
20–29 years	1.4	1.2–1.7		1.3	1.1–1.6		0.9	0.7–1.3		3.9	2.5–6.2	
30–39 years	1.8	1.5–2.2		1.9	1.6–2.4		1.0	0.7–1.4		4.6	2.8–7.5	
40–49 years	2.6	2.2–3.1		3.0	2.4–3.8		1.3	0.9–1.9		4.0	2.3–6.7	
50–59 years	2.9	2.4–3.5		3.4	2.7–4.2		1.5	1.0–2.2		5.4	3.1–9.3	
60–69 years	3.0	2.5–3.7		3.5	2.8–4.4		2.6	1.8–3.7		2.6	1.4–4.7	
70–79 years	3.5	2.9–4.2		3.7	2.9–4.7		4.2	2.9–6.1		2.9	1.5–5.3	
80+ years	4.9	3.9–6.1		3.2	2.4–4.2		12.8	8.8–18.6	<0.001	2.1	0.9–4.6	<0.001
Married	1.0			1.0			1.0			1.0		
Never married	2.1	1.9–2.3		1.7	1.6–2.0		2.7	2.1–3.3		4.7	3.6–6.2	
Divorced	1.6	1.4–1.8		1.3	1.1–1.5		1.6	1.2–2.2		5.3	4.0–7.1	
Widow or widower	1.4	1.2–1.6		1.2	1.0–1.4		1.5	1.2–1.9	<0.001	4.1	2.7–6.2	
Rest of Denmark	1.0			1.0			1.0			1.0		
Metropolitan Copenhagen	1.6	1.5–1.7		1.4	1.3–1.6		1.5	1.3–1.8	<0.001	2.5	2.1–3.0	<0.001
1987	1.0			1.0			1.0			1.0		
1991	0.9	0.8–1.0		1.0	0.9–1.1		0.9	0.7–1.0		0.8	0.6–1.0	
1994	1.1	1.1–1.2		1.4	1.3–1.5		1.0	0.9–1.2	NS	0.4	0.4–0.6	<0.001
Rest of Denmark												
16–19 years	1.0			1.0								
20–29 years	1.3	1.1–1.6		1.2	0.9–1.5							
30–39 years	1.6	1.3–2.0		1.7	1.3–2.2							
40–49 years	2.4	2.0–3.0		2.8	2.2–3.6							
50–59 years	2.5	2.0–3.1		2.8	2.2–3.6							
60–69 years	2.7	2.2–3.3		3.0	2.3–3.8							
70–79 years	3.0	2.4–3.8		3.1	2.4–4.1							
80+ years	4.5	3.5–5.8		2.6	1.9–3.6							
Metropolitan Copenhagen												
16–19 years	1.1	0.8–1.5		0.9	0.6–1.4							
20–29 years	2.1	1.7–2.7		1.4	1.0–1.9							
30–39 years	2.7	2.1–3.4		2.5	1.8–3.4							
40–49 years	3.0	2.3–3.9		3.1	2.3–4.2							
50–59 years	4.9	3.7–6.4		5.3	3.9–7.2							
60–69 years	4.6	3.5–6.0		5.2	3.8–7.1							
70–79 years	5.4	4.1–7.1		5.3	3.8–7.3							
80+ years	6.5	4.6–9.0	0.020	4.7	3.1–7.2	0.003			NS			NS
Men												
Married	1.0			1.0						1.0		
Never married	1.1	0.8–1.4		0.9	0.6–1.2					3.3	1.6–7.0	
Divorced	1.9	1.6–2.3		1.4	1.1–1.7					8.6	5.9–12.5	

Table 2 (continued)

	All non-respondents			Refusals			Ill, disabled, in hospital			Not contacted		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Widower	2.5	2.2–2.8		2.0	1.7–2.3					6.4	4.6–9.1	
Women												
Married	1.1	1.0–1.2		1.1	1.0–1.3					1.0	0.7–1.5	
Never married	1.5	1.3–1.7		1.4	1.2–1.7					3.4	2.1–5.6	
Divorced	1.5	1.3–1.8		1.4	1.1–1.7					2.6	1.6–4.2	
Widow	1.9	1.6–2.1	<0.001	1.7	1.4–2.0	0.033			NS	3.1	2.1–4.5	<0.001
Age × survey year (figure 2)			<0.001			0.020			NS			NS
Gender × age (figure 1)			0.003			0.018			NS			NS

NS, not significant

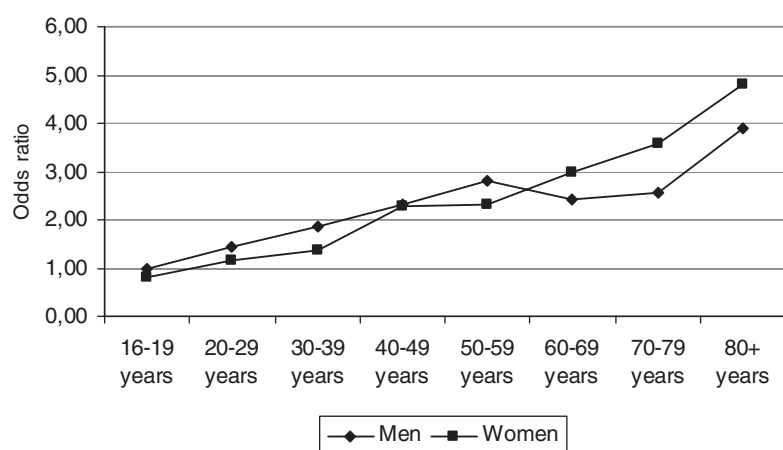


Figure 1 Odds ratio for non-response among men and women in various age groups

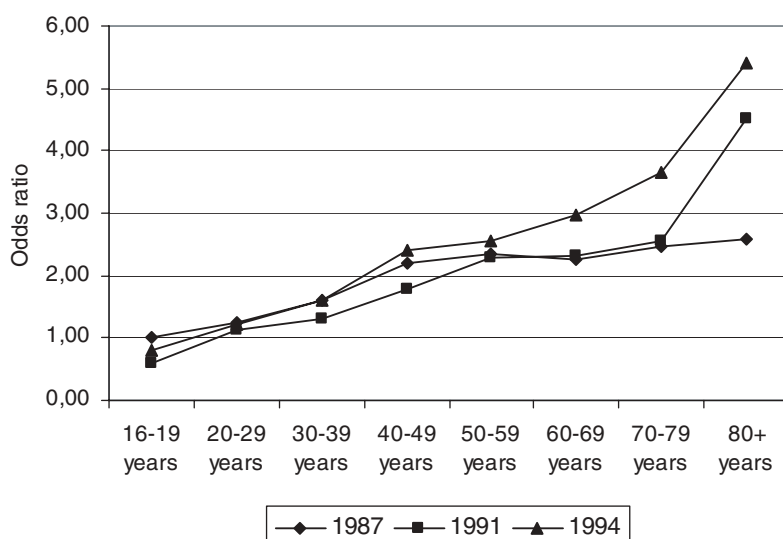


Figure 2 Odds ratio for non-response among various age groups in the three surveys

Hospital admission rates among respondents and non-respondents

Estimates of morbidity prevalence for HIS are based on information from the respondents and not from the non-respondents. Although our respondents and non-respondents differed statistically significantly in hospital admission rates, these

differences are insufficient to bias the admission rate among the respondents. First, the admission rate among respondents and non-respondents was identical before data collection, which indicates that the respondents and non-respondents had identical morbidity. Further, the identical admission rates indicate that the two groups are equally representative of the population from which they were selected. Second, the crude admission rate

Table 3 Test of the Poisson model for gender- and age-standardized hospital admission rates for total non-response and for each non-response category

Period (6-month intervals)	Rate ratio	P
Total non-respondents versus respondents		
–10 to –7	1.0	0.3984
–6 to –3	1.0	0.9254
–2 to –1	1.1	0.0070 ^a
Data collection (0 and 0)	1.3	0.0001 ^a
+1 to +4	1.1	0.0687
Refusals versus respondents		
–10 to –7	0.9	0.0008 ^a
–6 to –3	0.9	0.0050 ^a
–2 to –1	0.9	0.0120 ^a
Data collection (0 and 0)	1.0	0.9871
+1 to +4	1.0	0.6867
Ill, disabled or in hospital non-respondents versus respondents		
–10 to –7	1.3	0.0001 ^a
–6 to –3	1.3	0.0001 ^a
–2 to –1	1.9	0.0001 ^a
Data collection (0 and 0)	2.0	0.0001 ^a
+1 to +4	1.2	0.0027 ^a
Not contacted non-respondents versus respondents		
–10 to –7	1.0	0.9379
–6 to –3	1.1	0.5139
–2 to –1	1.3	0.0230 ^a
Data collection (0 and 0)	1.6	0.0002 ^a
+1 to +4	1.1	0.4084

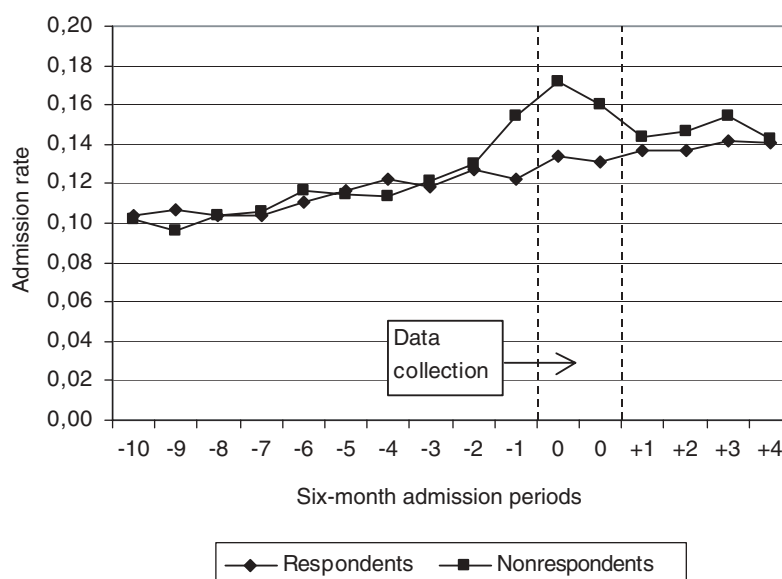
a: Statistically significant

(not adjusted for gender and age) from date of interview to end of study is 0.126 for respondents and 0.131 for the total group of respondents and non-respondents. This means that there is no major bias in admission rates. Third, the admission rate among respondents gradually but steadily rose during the entire period, and this trend did not change during data collection. If the admission rate during data collection had differed more between respondents and non-respondents, a declining admission rate among respondents would be expected based on selection. Fourth, the admission rate among both respondents and non-respondents rose slightly during the whole period, which may express the general increase in morbidity with increasing age.

Besides the differences in hospital admission rates between respondents and non-respondents, we also found significant differences between respondents and the ill or disabled non-respondents and between the respondents and those not contacted. Respondents and refusals did not differ. The ill or disabled non-respondents had a higher admission rate than the respondents for the entire period. This was expected, as this group was delimited based on information received by the interviewers from the invited people or their families.

Non-response analyses for general surveys mostly find greater morbidity among non-respondents than among respondents.^{12,14,19,20,22,23} This is partly in accordance with our results, although they only show higher morbidity (hospital admission rate) for a limited period immediately before and during the data collection. Analyses of non-response in several disease-specific surveys, however, indicate higher morbidity and a higher prevalence of risk factors for the diseases concerned among respondents than among non-respondents.^{27,28} These studies thus imply that personal involvement in surveys that closely investigate people's own situation or their potential risk factors provides special motivation for participation and thus influences the composition of the non-respondents.

If we had solely observed the admission rates during data collection, we could falsely have concluded that the survey results would underestimate the actual morbidity in the population. Further, the analysis of the various non-response categories shows that non-respondents are not a large homogeneous group but comprise various subgroups with varying socio-demographic composition and varying patterns of hospital admission.

**Figure 3** Gender- and age-standardized hospital admission rates (proportion having at least one admission during the relevant 6-month period) for respondents and non-respondents

In the survey we used indicators of morbidity covering a time period of 6 months. Therefore especially the increase in morbidity among non-respondents in the period immediately before the data collection phase could indicate risk of underestimating the actual morbidity in the population.

Socio-demographic factors and non-response

Non-response in the Danish Health Interview Surveys increased from 20.0% in 1987 to 22.4% in 1994. This increased to 25.6% in the survey in 2000.³⁵ Refusals accounted for most of the increase (increasing from 12.1% in 1987 to 16.4% in 1994). Non-response in national surveys is also increasing in Sweden and Norway: from 14% in 1980 to 23% in 1998 in Sweden³⁶ and from 11.5% in 1975 to 25.0% in 1995 in Norway.³⁷

Many factors may influence the increase in non-response. Individualism is generally increasing and willingness to follow authority decreasing. The number of surveys has increased substantially in most countries, and if participating has not been a positive experience, people are less likely to participate in other surveys. Factors explaining the increasing proportion of those not contacted in the total non-respondents include changing family patterns, with more people living alone and people using more time outside the home on work, transport and leisure activities. These factors make contacting the selected people more difficult. Our data collection method in the 1994 survey showed, however, that further efforts to contact people not contacted in previous rounds of data collection reduced the proportion of people not contacted.³²

Many non-response studies solely analyse the main effects of socio-demographic and other parameters. We included all two-way interactions. This produces a more accurate picture of which factors influence non-response and trends therein. Age was an important factor in non-response in our study. Non-response increased with age, but the age effect was not independent and was associated with the gender of non-respondents and with the trend in the pattern of non-response from 1987 to 1994. In a mailed questionnaire survey of health care utilization, Lamers¹⁵ similarly found that gender and age interacted, as men had a higher response rate than women among those aged 65–74 years and women had a higher response rate among those aged 15–54 years.

The interactions between gender and age and between gender and civil status may explain why few non-response analyses have found a main effect of gender,^{6,12,16} and why they do not clearly show whether men or women have higher non-response. Although we found that the pattern of non-response clearly differed between women and men, this may be eliminated in analyses that solely include gender as a main effect.

The substantially higher non-response in metropolitan Copenhagen than in the rest of Denmark corresponds to other studies finding greater non-response in highly urbanized areas.^{6,15}

This study allowed us to investigate various types of non-response, categorized as refusals, not contacted and ill, disabled or hospitalized people. However, comparing our results on the composition of non-response in the various categories with those of other studies is difficult. Few studies have analysed subgroups of non-respondents and the groups of non-respondents are delimited differently.^{6,8,9} Nevertheless, in a nationwide survey of non-institutionalized people in Japan who were 60 years or older in which 67% were interviewed, Jay *et al.*⁶ found that gender was an explanatory factor for refusals and not contacted, but not for other non-respondents, which included ill people and others. Similarly, we found no difference in men's and women's odds of non-response because of being ill or disabled. Similar to our study, Jay *et al.* further found that age and urbanization were important factors for non-response in each of the categories of refusals, not contacted and others.

Overall, non-response increased from 1987 to 1994, mostly due to an increase in refusals. The composition of the non-respondents was largely constant from 1987 to 1994. Hospital admission rates differed between respondents and non-respondents immediately before and during data collection, while no differences were found during the other time periods. Further admission rates differed between respondents versus not contacted non-respondents and versus ill or disabled non-respondents but not versus refusals. Nevertheless, the overall differences between respondents and non-respondents were too small to lower the admission rate among respondents and consequently also too small to bias the estimates of morbidity based on the responders in the Danish Health Interview Surveys.

Acknowledgement

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Key points

- Non-response in Health Interview Surveys might bias the estimated population morbidity.
- Non-response increased in Denmark – from 20% in 1987 to 23% in 1994 – but the composition was constant.
- Hospital admission rates among responders and non-responders differed only immediately before and during data collection.
- The differences were too small to bias the estimation of morbidity based on responders in the Danish HIS.

References

- 1 Picavet HS. National health surveys by mail or home interview: effects on response. *J Epidemiol Community Health* 2001;55:408–13.
- 2 WHO. *Health interview surveys – Towards international harmonization of methods and instruments*. Copenhagen: WHO Regional Publications, 1996.
- 3 Eaker S, Bergstrom R, Bergstrom A *et al.* Response rate to mailed epidemiologic questionnaires: a population-based randomized trial of variations in design and mailing routines. *Am J Epidemiol* 1998;147:74–82.
- 4 Lund E, Gram IT. Response rate according to title and length of questionnaire. *Scand J Soc Med* 1998;26:154–60.
- 5 Hupkens CL, van den BJ, van der ZJ. National health interview surveys in Europe: an overview. *Health Policy* 1999;47:145–68.
- 6 Jay GM, Liang J, Liu X, Sugisawa H. Patterns of nonresponse in a national survey of elderly Japanese. *J Gerontol* 1993;48:S143–52.
- 7 Etter JF, Perneger TV. Analysis of non-response bias in a mailed health survey. *J Clin Epidemiol* 1997;50:1123–8.
- 8 Ohlson CG, Ydreborg B. Participants and non-participants of different categories in a health survey. A cross-sectional register study. *Scand J Soc Med* 1985;13:67–74.
- 9 Boersma F, Eefsting JA, van den BW, van Tilburg W. Characteristics of non-responders and the impact of non-response on prevalence estimates of dementia. *Int J Epidemiol* 1997;26:1055–62.
- 10 Reijneveld SA, Stronks K. The impact of response bias on estimates of health care utilization in a metropolitan area: the use of administrative data. *Int J Epidemiol* 1999;28:1134–40.
- 11 Shahar E, Folsom AR, Jackson R. The effect of nonresponse on prevalence estimates for a referent population: insights from a population-based cohort study. Atherosclerosis Risk in Communities (ARIC) Study Investigators. *Ann Epidemiol* 1996;6:498–506.
- 12 van den Akker M, Buntinx F, Metsemakers JF, Knottnerus JA. Morbidity in responders and non-responders in a register-based population survey. *Family Practice* 1998;15:261–3.

- 13 Augustsson O, Eriksson BG, Rosenhall U et al. The Johanneberg study—a sociomedical survey in an urban elderly population. I. General presentation of the study including an analysis of non-response and identification of risk groups. *Scand J Soc Med* 1994;22:283–92.
- 14 Launer LJ, Wind AW, Deeg DJ. Nonresponse pattern and bias in a community-based cross-sectional study of cognitive functioning among the elderly. *Am J Epidemiol* 1994;139:803–12.
- 15 Lamers LM. Medical consumption of respondents and non-respondents to a mailed health survey. *Eur J Public Health* 1997;7:267–71.
- 16 Chou P, Kuo HS, Chen CH, Lin HC. Characteristics of non-participants and reasons for non-participation in a population survey in Kin-Hu, Kinmen. *Eur J Epidemiol* 1997;13:195–200.
- 17 Heilbrun LK, Ross PD, Wasnich RD et al. Characteristics of respondents and nonrespondents in a prospective study of osteoporosis. *J Clin Epidemiol* 1991;44:233–9.
- 18 Qvist J. *Analysis of nonresponse in the SCB-surveys HINK and ULF*. Örebro: Statistics Sweden, 2000.
- 19 Hoeymans N, Feskens EJ, Van Den Bos GA, Kromhout D. Non-response bias in a study of cardiovascular diseases, functional status and self-rated health among elderly men. *Age Ageing* 1998;27:35–40.
- 20 Midthjell J, Forsen L, Skjerve K et al. [A health survey in Nord-Trøndelag 1984–86. Participation and comparison of attendants and non-attendants]. *Tidsskr Nor Lægeforen* 1990;110:1973–7.
- 21 Hebert R, Bravo G, Korner-Bitensky N, Voyer L. Refusal and information bias associated with postal questionnaires and face-to-face interviews in very elderly subjects. *J Clin Epidemiol* 1996;49:373–81.
- 22 Jackson R, Chambless LE, Yang K et al. Differences between respondents and nonrespondents in a multicenter community-based study vary by gender ethnicity. The Atherosclerosis Risk in Communities (ARIC) Study Investigators. *J Clin Epidemiol* 1996;49:1441–6.
- 23 Pietila AM, Rantakallio P, Laara E. Background factors predicting non-response in a health survey of northern Finnish young men. *Scand J Soc Med* 1995;23:129–36.
- 24 Criqui MH, Barrett-Connor E, Austin M. Differences between respondents and non-respondents in a population-based cardiovascular disease study. *Am J Epidemiol* 1978;108:367–72.
- 25 Adams MM, Scherr PA, Branch LG et al. A comparison of elderly participants in a community survey with nonparticipants. *Public Health Rep* 1990;105:617–22.
- 26 Vestbo J, Rasmussen FV. Baseline characteristics are not sufficient indicators of non-response bias follow up studies. *J Epidemiol Community Health* 1992;46:617–9.
- 27 Ives DG, Traven ND, Kuller LH, Schulz R. Selection bias and nonresponse to health promotion in older adults. *Epidemiology* 1994;5:456–61.
- 28 Rupp I, Triemstra M, Boshuizen HC et al. Selection bias due to non-response in a health survey among patients with rheumatoid arthritis. *Eur J Public Health* 2002;12:131–5.
- 29 Osler M, Schroll M. Differences between participants and non-participants in a population study on nutrition and health in the elderly. *Eur J Clin Nutr* 1992;46:289–95.
- 30 Rockwood K, Stolee P, Robertson D, Shillington ER. Response bias in a health status survey of elderly people. *Age Ageing* 1989;18:177–82.
- 31 Kjølner M, Thomsen LK, Rasmussen NKr. *Befolkningens forebyggelse af muskel- og skeletsygdom*. [Population Prevention of Musculoskeletal Diseases in Denmark]. København: DIKE, 1993.
- 32 Kjølner M, Rasmussen NKr, Keiding L, Petersen HC, Nielsen GA. Sundhed- og sygelighed i Danmark 1994 – og udviklingen siden 1987. The Danish Health and Morbidity Survey 1994]. København: DIKE, 1995.
- 33 Rasmussen NKr, Groth MV, Bredkjær SR et al. *Sundhed og sygelighed i Danmark 1987*. [The Danish Health and Morbidity Survey 1987]. København: DIKE, 1988.
- 34 Helweg-Larsen K, Kjølner M, Davidsen M et al. The Danish National Cohort Study (DANCOS). Registry-based follow-up study of The Danish Health Interview Surveys, 1987, 1991 and 1994. *Dan Med Bull* 2003;50:177–80.
- 35 Davidsen M, Kjølner M. The Danish Health and Morbidity survey 2000 – design and analysis. *Statistics in Transition* 2002;5:927–942.
- 36 Nilsson P, Ahtaiainen A, Bergdahl M et al. *Bortfallsbarometer nr 14*. [Nonresponse barometer no. 14]. Stockholm: Statistiska centralbyrån, 1999.
- 37 Belsby L. Frafallsproblemet øker. [Nonresponse problems are increasing]. *Samfunnsspeilet* 1997;nr 2:10–13.

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